# Emotional Experience with Portable Health Devices

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**Abstract**: This paper reports on a six month longitudinal study exploring people's personal and social emotional experience with health related portable interactive devices (PIDs). The focus is on emotions and how health PIDs mediate this experience in everyday contexts. The study reported here is an extension of a previous experiment conducted by the authors exploring media related PIDs [1]. The findings identified interesting aspects of health device interaction. Findings revealed people interact with health PIDs emotionally both at a personal and a social level. However, in contrast to media PIDs, participants reported significantly less social experiences than personal experiences. Nevertheless, the social level plays an important role such that negative social experiences had a significant influence on the perceived emotional experience over the course of six months. When no negative social experiences were reported the emotional experience over the course of six months became neutral. The findings are discussed in regards to their significance to the field of design, their implication for future health PID design and future research directions.

***Key words: Experience, emotion, portable health devices, longitudinal study, qualitative***

## 1. Introduction

Emotions are central to the human experience. Whether consciously or not emotions filter people's thoughts, behaviours, attention, perception, memory and decision-making through our everyday activities. This is especially relevant in regards to health and wellbeing. Emotions have a significant role to play in how people feel about themselves and about their health [2]. Thus, devices that assist in the health process should be designed to support and improve the recovery or quality of life of people through their interactions in everyday life. Currently, there exists a multitude of portable interactive devices (PIDs) that are said to assist with personal health including heart rate monitors, pedometers, blood-glucose monitors among others. It seems the proliferation of these health related PIDs is set to continue with various health-care companies said to be investing in portable health device technologies [3,4,5,6]. Likewise, Frog Design, a design company based in the United States published an article in collaboration with health-care providers, insurers, employers, consumers, governments, and technology companies illustrating a vision of the future for health care, which included a significant application and use of portable devices for personal and social use [7]. So although on the one hand there is a link between people's emotions and their health and on the other a growing momentum for the advancement of portable health devices from the medical industry there currently appears to be little research available specifically looking at the emotional experience of interaction with health related PIDs.

Health related PIDs pose an interesting challenge as they present new means of interacting with the world; influencing the way people relate to their own health, personal fitness, general wellbeing and quality of life. Further, with these devices being portable, health issues are no longer confined to private contexts as they can now be used anywhere, anytime and expose what has previously been a private experience into the public realm. So what does this change mean for people who interact with health PIDs? How do these devices affect the way people experience personal health in various contexts and over time? In what way can these devices support desired experiences? To answer these questions, a study on how health PIDs fit within the broader social and emotional context of everyday is necessary. This shifts the focus away from the product and draws attention to the people and the activities they wish to undertake. Picard and Wexelblat [8] support this view by outlining "systems that ignore the emotional components of human life are inevitably incomplete and inferior".

## 2. The Importance of Portable Health Devices

In recent years there has been a call for a shift in healthcare service provisions from large centralized institutions to healthcare systems and devices that are distributed and accessible to everyone anytime, anywhere [5,9,10]. This shift has been driven by the increasing cost of healthcare in the United States [11] and Europe [10] as well as a cultural change in regards to people actively becoming more eager to participate in their own health management. This has steered investment, research and development into portable and wireless technologies focusing on health status monitoring, healthy lifestyle and overall quality of life [10].

Current research in this area has focused on developing infrastructure and associated systems for wireless telemedicine [3,10,11,12]. These reports have mainly been produced to make the case for a shift in resources and research to support this potential future that is outlined. Other research has centred on the design of portable medical monitoring devices [13,14] mainly focused on developing, implementing, analysing and validating the functional aspects of the device including its effectiveness and efficiency in operation. Pentland [15] reports on the opportunities of future wearable and portable health devices but does not refer to the emotional effects these devices might have on potential users during interaction and what that might mean for the design of the devices. O'Sullivan, O'Donoghue, Herbert, and Studdert [16] also report on some interesting aspects of the development, use and testing of context-aware wearable medical devices; however the devices are specifically designed for healthcare professionals and doctors, not for patients. Likewise, Reiner [17] conducted a study of a portable respiratory assistance device over a 3 week period with participants but focused mainly on the effectiveness of the device for treatment of particular anxiety disorders. Although there was an examination on emotional aspects of using the device this had more to do with patient response to the treatments rather than how they felt regarding their use of the product and how it fit into their daily lives. Perhaps the work conducted by Shah [18] best relates to the approach taken in this study. Shah conducted an experiment to explore how pleasurable user interactions and situated computing can increase patient compliance with physician recommendations, as well as aid patients in making better health-related decisions. However; although pleasurable aspects of interaction is mentioned as a focus of the research it is not clear how this was studied in the investigation.

The view taken here is that the fundamental step in making new technology usable, practical and ultimately enjoyable requires investigating and understanding people and their experiences with artefacts in everyday

situations; and designing the artefacts based on that critical understanding. The purpose is to bridge the gap found in the available literature in respect to health PIDs including heart-rate monitors and pedometers. The approach reflects experience design [19,20,21] and the work conducted by Dourish [22] whereby the concern is not purely the physical interface of the products or its usability aspects but rather the ways in which they are experienced in everyday contexts. The research centers on exploring emotional interactions with health PIDs in real life contexts over time. The research objectives include: (i) focusing mainly on the **emotional** aspects of interaction; (ii) situating experiences within **real life contexts** and situations and (iii) observing these evolving emotional experiences **over time.** The rationale is that poorly or ineffectively designed devices in regards to these aspects increase the potential for patients disregarding safety precautions, minimise proper use and care of devices and generally create a negative feeling toward themselves and the device, which could result in severe detrimental health outcomes. Devices that positively influence the experience of use have a greater opportunity to be used more thoroughly, consistently and lead to positive outcomes and feelings about their health experiences. The aim is to enable designers not only to design usable and functional devices but also to better understand how to support and enhance the evolving emotional experience between people and health PIDs in everyday contexts.

## 3. Theoretical Framework

To appreciate interactions between people and artifacts in context Activity Theory has been used as a theoretical framework. Activity Theory deals with engagement in a real world context, rather than abstract ideas about interactions [23]. Understanding how people perceive and act in real life contexts is crucial and forms the basis for understanding how they perceive the world [24]. In this way, artefacts become the means to an end, not the end itself and as such are appropriately viewed simply as mediators for human experience. There are three main aspects to consider: (i) activities through time; (ii) activities within context and (iii) people are not merely agents in a system, they have motives/intentions/emotions.

Conceptually, Activity Theory considers activities as being composed of three levels with activities sitting at the highest level, composed of actions, in turn composed of operations at the lowest level [24]. This model explains a complex interaction dynamic in a simplified format. For instance to make a call with a mobile telephone a number is dialed (*operations*), a conversation ensues (*actions*) and a message is communicated (*activity*). The model also takes the dynamic nature of activities into account. For instance if in the attempt to make the call the mobile telephone does not function then the *activity* changes to finding out what the problem is, while the *action* may involve looking for error messages or checking if the device is on, and *operations* include pressing buttons and so on. This highlights the fact that activities are neither static nor one-dimensional. Activities exist on multiple levels simultaneously consisting of a global (or macro) level and a local (or micro) level [25]. In relation to this study the global-level is composed of the overall emotional experience over the course of six months, while the local-level is composed of the multitude of experiences recorded throughout that time. This perspective has certain implications for this study, which will be discussed in more detail in section 5.

## 4. Portable Health Devices in Everyday Contexts: A longitudinal study

An investigation was conducted exploring the emotional experience of interacting with health related PIDs in everyday use. The study is phase 2 of a larger investigation currently being conducted by the principle author and as such the method, research approach, aims and objectives replicates a previous study conducted by the research team [1]. As with the previous study the primary aims of the research were to observe what types of factors influence the emotional interaction with these types of devices. The objectives included:

(i) Observing the fluctuating relationships with health PIDs over the course of time (six months);
(ii) Determining the critical factors influencing the overall emotional experience; and
(iii) Outlining how these factors influence the overall emotional experience in a positive/negative way.

This paper reports on an experiment that studied participants who utilised heart-rate monitors and pedometers over the course of six months. Results from the investigation provide data to better understand how to appropriately design future health related PIDs to support positive (and avoid negative) emotional experiences in everyday situations.

### 4.1. Data Collection and Methods

The investigation centered on recording experiences with health PIDs in everyday life over the course of the initial six months of use. The investigation intended to capture initial stages of interaction and observe how much the experience and relationship between participant and product evolved over time. There were various complications with participant recruitment and retention throughout the investigation. In retrospect the authors believe this is due to the six month timeframe, which placed a significant time obligation on potential participants. There is literature to support using anywhere between 5-10 participants to collect enough data for the validity of studies relating to portable computing [26,27]. Although originally twelve participants were recruited, only six participants completed the entire study as it spanned six months. Three recorded their use with heart-rate monitors while three recorded their experiences with pedometers. Only users with no more than two months experience with the devices were recruited; thus attempting to capture the initial stages of interaction and how it evolved over the initial six months of use.

Data collection methods consisted of diaries, interviews and co-discovery. The triangulation approach helps to make the research and results more reliable and valid [28,29] and increases the theoretical generalisations emerging from the study [30]. The investigation was divided into the following four stages: initial interview, participant diaries, intermittent consultations and co-discovery. All data were recorded, transcribed and analysed using Atlas.ti software.

#### 4.1.1. Initial interview

The initial interview (15-20 minutes) was the first step of the investigation procedure. This entailed meeting the participants and explaining their involvement in the study. This interview centered on: (i) gaining knowledge about the participant's expectations of the product; (ii) emotions felt towards the product; (iii) the expectation of the benefits it might provide; and (iv) the expectations of possible challenges the device might present.

### 4.1.2. Participant diaries

The diaries were used by participants to record relevant interactions with the products as they experienced them over six months. They were asked to fill out the diary once a week. The structure of the diary provided for up to three experiences per week. Participants were asked to reflect primarily on the emotional experiences with the product during interactions by answering the following questions: (i) context of interaction (location/time/date); (ii) activity performed (purpose of use); (iii) who was present during interactions (alone/other people/crowd) and (iv) summary of their perception of the emotional experience (perceived emotional reaction to experience). The participants recorded the main details of their interactions with the product and rated the overall emotional experience using the Emotional Chart [25]. The Emotional Chart is based on Russel's [31] model of Core Affect and has been effectively used as a self-reporting tool in other studies investigating design and emotions [32,33,34].

### 4.1.3. Intermittent consultations

Between 5 and 8 intermittent consultations (semi-structured interviews) were conducted with participants over the six month period. The interviews took 15-20 minutes on average, and were recorded through audio and note-taking. Between two and three consultations were performed in the first month followed by one a month for the remaining five months. The purpose was twofold; regularly check any problems with the diary and record more detailed information about the experiences. Participants were asked: (i) on average how often have you used the product? (ii) how would you characterise your feelings towards the product? (iii) what have been some of the positive aspects? (iv) what have been some of the negative aspects of using the product? and (v) did the surrounding context (environmental or social) affect the use of the product in a positive or negative way?

### 4.1.4. Co-discovery

The final part of the study involved a co-discovery session between two and three participants. This part of the investigation focused on how their expectations in the beginning changed as their experiences with the products evolved over the six month period.

## 5. Coding

The data analysed were the diary responses obtained throughout the six month period involving up to 81 individual experiences for the six participants. This was analysed using content analysis technique [35,36]. To assist in contextualising the findings the data sets were split into two categories. Firstly, data relating to specific activities within the overall six month timeframe are referred to as local-level interactions (Section 3). For instance, a participant using the pedometer to go for a walk during the day would be an example of a local-level experience and could be analysed independently. Alternatively, during the interviews a participant may be asked how he/she felt about the product over the previous month and their response would be characterised as a global-level experience. As such, these global-level experiences were composed of many local-level interactions throughout. Table 1 shows the relationship between data gathering techniques and how data was categorised.

Table 1. Global-level and local-level experiences

| Data collection and Methods | Global-level experiences | Local-level experiences |
|---|---|---|
| Initial interview | ✓ | |
| Diary | | ✓ |
| Intermittent interview | ✓ | |
| Co-discovery | ✓ | |

## 5.1 Global-level Experiences

The first aspect analysed was the overall emotional experience reported by the participants across time (global-level interactions). This was performed by analysing the interviews conducted over six months. During the interview participants were asked to characterise their emotion toward the product. Figure 1 is an example from Participant 10c showing the global-level experience captured over the six month period. The X axis represents the participant's emotional response during the interview ranging from intense negative through neutral all the way to intense positive mirroring the quadrants represented on the emotional chart [25]. The Y axis denotes time in months. Each point represents the participant's emotional description during the interview. For example, during the sixth interview (month 4) the participant was asked how he felt about the product at that stage and his response was: "*Neutral. Some of the features I feel are inaccurate…*". This comment reflects a characteristic example that was coded as neutral in valence. As such, it was positioned in the "neutral" line on the graph. Figure 1 represents Participant 10c and the emotional experience over time. The flatness of the line reveals that the participant has recorded the experience as overall constant across six months.

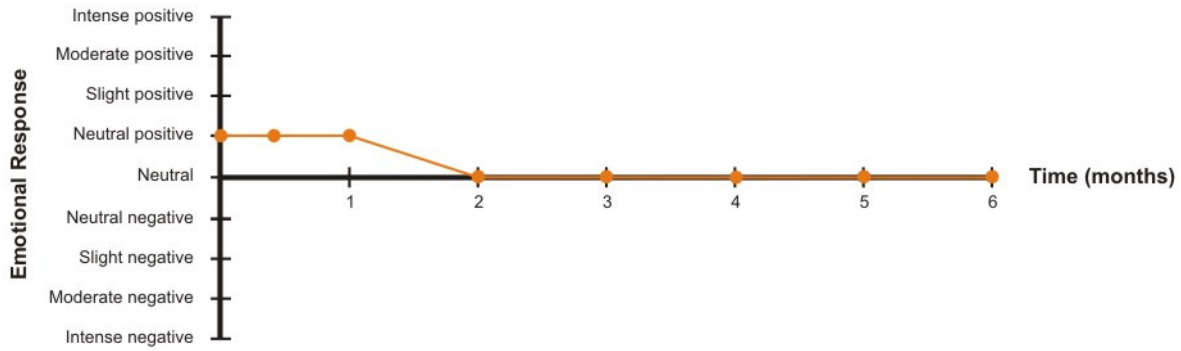


Figure. 1 Global-level: overall experiences plotted across time

## 5.2 Local-level Experiences

The local-level experiences were identified using the diary responses (Section 5). The diaries permitted up to three experiences a week over the six month period to be recorded. Participants were asked questions about their experiences such as; *who else was there and did their presence affect your use?* and *how did you feel about this experience?* The responses for the question; *who else was there and did their presence affect your use?* were coded and separated into personal and social interactions.

"Personal" interactions referred to activities performed in private or where other people nearby did not influence their experience. For instance, on one occasion Participant 10c responded:

*"No one was specifically close to me. Only other runners / walkers and cyclists. None of them affected my use of the product."*

This particular response was coded as "personal" since even though other people were present they were not perceived as affecting the participant's experience. "Social" interactions referred to activities in which the presence of other people was perceived as affecting the experience. For examples participant 15c, reported:

*"There were about 10 other runners…I would say that, yes, their presence did affect how I used the watch – because I was busy catching up and talking with some running friends…".*

This was coded as "social" as the presence of others was perceived to affect the participant's experience. These responses represent prototypical examples of answers for these questions from the diary responses.

## 6. Findings: Personal and Social Interactions

Once the diaries and interviews were performed the findings were examined to determine the relationships between the local-level and global-level interactions. Preliminary analysis of the local-level data supports the idea that health PIDs are used both at a personal level and at a social level but to a different extent to the previous study on media PIDs [1]. To date 81 experiences have been analysed for the health PID participant group. Out of these, 77% (approx 62 experiences) were noted as being personal while only 23% (approx 19 experiences) were noted as being social (Figure 2). This is in contrast to the previous experiment conducted with media PIDs where 33% of all experiences recorded were social, which represented more than a third of all experiences [1]. Here, figure 2 indicates that overall participants identified under a quarter of their experiences as social over the course of six months. This indicates that although there are social and personal experiences with health related PIDs participants perceived less of them as being social. Nevertheless; although personal interactions considerably outweighed social interactions the influence of social interactions was found to be central in influencing the overall emotional experience (Section 6.1).

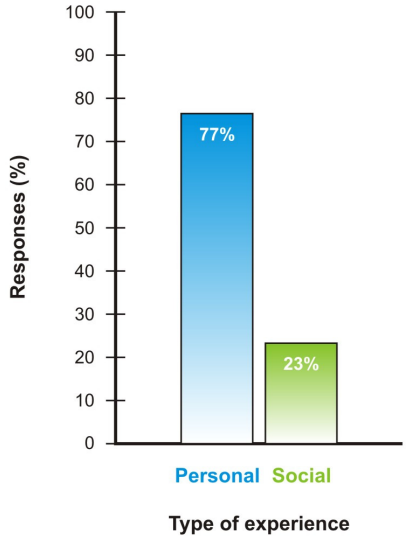


Figure. 2 Total percentage of personal and social interaction reported by all respondents

## 6.1 Relationship of Social Interactions on Perceived Emotional Experience

Similarly to the previous study conducted on media PIDs analysis has revealed that negative social interactions have a significant impact on the emotional experience perceived by participants. There was a direct relationship between negative social experiences and the effect on the overall experience reported. For example, if a participant reported negative social experiences this would impact negatively on the global-level experience graph such that there would be a significant drop in the reported emotional experience and it would drop below the 'neutral' line. In contrast, if a participant reported no negative social experiences this did not influence negatively on the global-level emotional experience reported. The graph in this case would not drop below the neutral line and would stay relatively consistent over the course of six months. This relationship was evident across all participants.

This relationship indicates that negative social experiences for health PIDs have an immediate influence on the overall emotional experience, while negative personal experiences do not appear to have the same effect. This same effect was not evident with the media PIDs previously studied. Figures 3 and 4 illustrate this particular phenomenon and are typical of all responses. The nature of the participant's experience over the course of time is plotted on a graph and the corresponding negative social and negative personal experiences are indicated on the graph. Figure 3 shows the global-level experiences of participant 15c and illustrates how the experience is influenced in a downward direction by the negative social experience reported (labeled **ns**) while influenced differently by negative personal (labeled **np**). Figure 4 shows the global-level experiences of participant 13d and illustrates how the experience is generally constant over time and is not particularly influenced by the negative personal experience reported (blue – labeled **np**). By identifying the negative social experiences and the negative personal experiences reported across the timeline it can be seen how they influence the reported emotional experience immediately following. If negative social experiences are reported there appears to be a negative effect on the graph whereas negative personal experiences do not appears to influence the graph in the same manner.

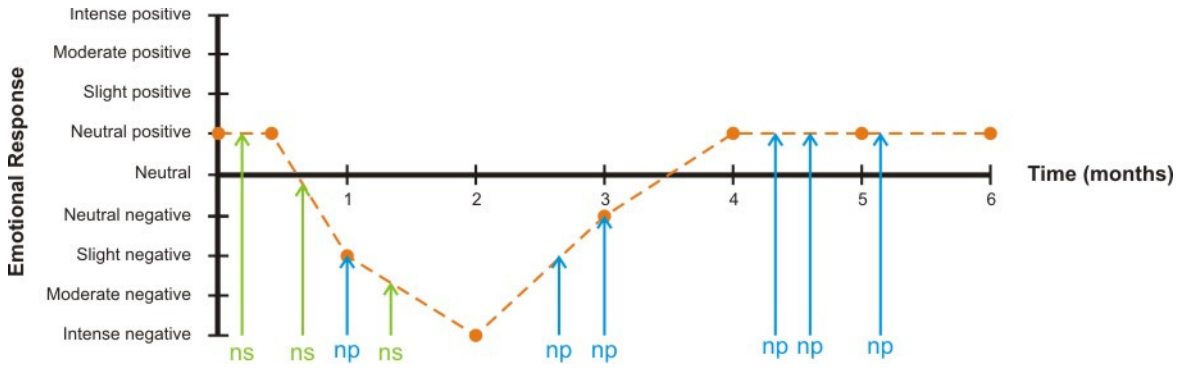


Figure. 3 Global-level experiences: Participant 15c (dotted line) overall experience and corresponding negative social experiences (green line: labeled **ns**) and negative personal experiences (blue line: labeled **np**)

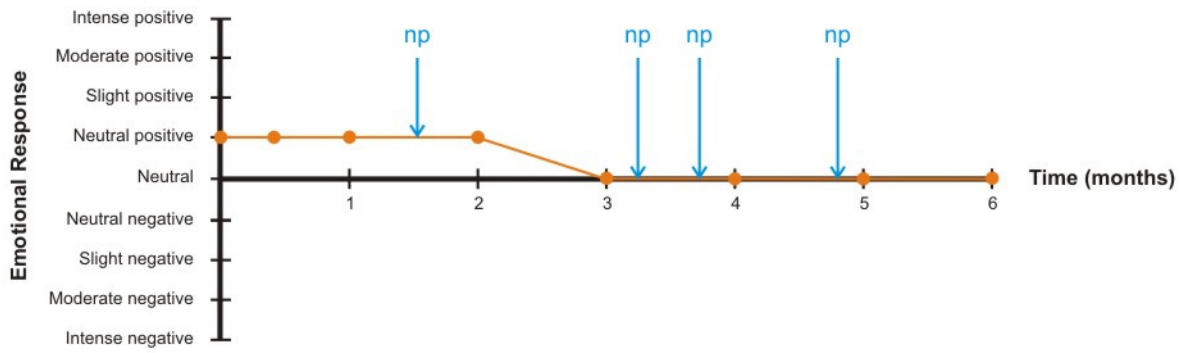


Figure. 4 Global-level experiences: Participant 13d (full line) overall experience and corresponding negative personal experiences (blue line: labeled **np**)

Figures 3 and 4 illustrates that if participants experience negative social experiences the negative impact on the experience is immediate. On the other hand if no negative social experiences are recorded the perceived experience is not affected significantly, regardless of the amount of negative personal experiences recorded. Thus, social experiences for health PIDs have a direct relationship and are intricately intertwined with the perceived emotional experience while personal experiences are not.

## 7. Implications for Design

As Gloyd [37] argues "non-adherence with medical recommendations is a major contributor to therapeutic failure, a source of frustration for health care providers, and is considered by many to be one of the most serious problems facing medicine today". Gloyd contends that interaction design and the field of industrial design plays a crucial role in improving this situation. Likewise Hirsch et al. [38] comment that failure to consider emotional aspects of interaction can result not only in missed opportunities for innovation but also lowers the adoption and use of health devices. As such the importance of positive affect during everyday experiences is a critical component in the process that leads to adherence to medical recommendations and device usage.

In relation to this paper two findings from the study are reported. Figure 2 demonstrates that health PIDs are used for personal as well as social interactions supporting other studies conducted in this area using portable devices as well as a previous experiment conducted by the authors [1,39]. Nevertheless, compared to the previous study conducted by the author focusing on media PIDs, the proportion of social experience was significantly less in this instance compared with personal experience. Figure 3 and 4 support the importance of social interactions on the overall emotional experience. It was noted that negative social experiences were directly related to the perceived emotional experience. For instance if negative social experiences were reported this would instantly negatively influence the ongoing emotional experience. The same did not occur for negative personal experiences. The design of future health PIDs need to take this into account, as any negative social interaction experienced during use contribute directly to a negative perceived emotional experience over the course of time and contribute to the reduction of the adherence and correct use of health devices, with potential harmful effects on the user [38].

Similarly to the previous study [1], although in a distinctly different way, emotions occurring at the social level are of primary importance for the development of how people perceive themselves and how they interrelate with the surrounding world. As such, emotions experienced in social settings are crucial to people's perception of everyday interactions over time. Health PIDs are indeed personal but more importantly there exists the social dimension which impacts considerably on the emotional experience perceived by the user. When considering health related PIDs negative social experiences need to be avoided as they tend to influence the overall emotional experience in a contrary fashion.

At this stage specific findings on the product interface of health PIDs have not been reported because analyses into these aspects have not been completed. Nevertheless, the intention is to identify explicit results that focus on the product interface so as to inform and make recommendations that will assist designers in having a better understanding and enable them to design health PIDs that will create positive emotional experiences with people over time.

## 8. Conclusions and Further Work

Emotions are central to everyday experiences including interactions with surrounding products and devices. This paper reported on a study that explored people's emotional experience with health related PIDs, including heart-rate monitors and pedometers, over the first six months of use. The users and their emotional experiences with products in everyday settings was the fundamental starting point. The investigation conducted revealed the social dimension of interaction with these types of PIDs is critical in determining the overall emotional experience over time. This supports and builds on a previous study conducted by the authors using media PIDs [1]. When considering the overall experience the intent is to create ongoing positive relationships with health related products as this assists in adherence to proper product use and reduce the chance of non-adherence on behalf of users [37,38]. Findings suggested that if negative social experiences were experienced then the overall experience was perceived as negative. Consequently it is important to consider how the design of PIDs are integrated into and impact the social dimension of interaction as any negative experiences on a social level will be counter-productive to the overall experience perceived by the user. This particular finding is a significant contribution to the area of design and emotion and for the design of future health related PIDs, especially in regards to how people interact with these devices over time in real life contexts.

Further analysis can now be performed on the data to identify additional relationships at different levels of interaction. This includes looking at the local-level of interactions to determine what extent elements like context, setting, time of day and type of interaction impact on the overall emotional experience. Likewise a more detailed analyses into the product interface on the emotional experience is currently being conducted to identify aspects that will provide information relating to the impact of the interface design on the overall emotional experience. Further comparisons can also be performed between media PIDs and health PIDs. The intent is to compare and analyse the relationships between the two different product types. It is envisioned that this comparison will lead to a better understanding as to whether there are similar aspects to these product categories or if there are distinct variations between people's relationship, the influencing factors and the emotional connections between media

and health devices in everyday contexts. It is predicted that interesting trends about peoples use with these two varied portable device categories will be revealed.

## 9. Acknowledgement

The research team would like to thank all of the participants involved in the study. Without their voluntary commitment the research would not be possible.

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